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(54) [Title of the Invention] METHOD FOR MANUFACTURE OF PRINTED CIRCUIT SUBSTRATE

(57) (Abstract)

[Structure] In a method for the manufacture of a printed circuit substrate by inserting a glass cloth prepreg impregnated with an epoxy resin or a stack of several such prepgs between mirror-finished metal sheets and applying pressure under heating, the prepreg is used which is obtained by impregnating the fiber substrate with a varnish containing a filler having a thermal expansion coefficient lower than that of the resin and then impregnating with a varnish containing no filler.

[Effect] The printed circuit substrate has a small surface roughness and excellent smoothness. Moreover, the peeling strength of copper foils is high. Therefore, it is perfectly suitable as a printed circuit substrate for high-density patterning.

[Patent Claims]

[Claim 1] A method for the manufacture of a printed circuit substrate by inserting a prepreg obtained by impregnating a fiber substrate with a thermosetting resin varnish or a stack consisting of a plurality of such preprints between mirror-finished metal sheets and applying pressure under heating, wherein the prepreg is obtained by impregnating the fiber substrate with a varnish containing a filler having a thermal expansion coefficient lower than that of the resin and then impregnating with a varnish containing no filler.

[Detailed Description of the Invention]

[0001]

[Field of Industrial Utilization] The present invention relates to a method for the manufacture of a printed circuit substrate with a small surface roughness and high density.

[0002]

[Prior Art Technology] Laminates with a small surface roughness have been manufactured by the methods comprising: (1) using preprints with a high resin content or preprints with a low resin flow; (2) using fiber substrates such as thin glass cloth; or (3) adding a filler with a small thermal expansion coefficient to the resin. The drawback of method (1) was that the allowed range of molding pressure was low and the spread in the laminate thickness was large. The drawback of method (2) was that the glass cloth cost was high and glass clothes of different types were used which resulted in additional processing stages. The drawback of method (3) was that the filler distribution could easily be non-uniform, characteristics were destabilized, molding was made difficult, and color tone varied between the substrates.

[0003] In recent years, the demand for high-density miniature circuits has greatly grown. In order to reproduce accurately a photographically transferred pattern in the formation of a circuit on a laminate, it is necessary to minimize the size of peaks and valleys on the surface of a metal foil employed to form a circuit. Accordingly, the demand for laminates with a small surface roughness has increased.

[0004]

[Problems Addressed by the Invention] The object of the present invention is to obtain a printed circuit substrate with a small surface roughness. The present invention makes it possible to obtain a printed circuit substrate with a small surface roughness by conducting impregnation with a varnish containing a filler and a varnish containing no filler in the preparation of a prepreg by impregnating a fiber substrate with a thermosetting resin varnish.

[0005]

[Means to Resolve the Problems] The present invention relates to a method for the manufacture of a printed circuit substrate with a small surface roughness by inserting a prepreg obtained by impregnating a fiber substrate with a thermosetting resin varnish or a stack consisting of a plurality of such preprints between mirror-finished metal sheets and applying pressure under

heating, wherein the prepreg is obtained by impregnating the fiber substrate with a varnish containing a filler having a thermal expansion coefficient lower than that of the resin and then impregnating the substrate with a varnish containing no filler.

[0006] The filler employed in accordance with the present invention has a thermal expansion coefficient lower than that of the thermosetting resin impregnated into the fiber substrate. Inorganic fillers are suitable for this purpose. Examples of preferred fillers include short glass fibers, glass beads, glass balloons, aluminum hydroxide, aluminum oxide, clay, talc, wollastonite and the like. The appropriate amount of the filler is within a range from 30 to 70 wt.% based on the total content of solids in the varnish. If the amount of filler is less than 30 wt.%, the effect of smoothing the substrate surface is insufficient, and when the filler amount is more than 70 wt.%, the varnish viscosity increases and the impregnation of the fiber substrate is incomplete.

[0007] No specific limitation is placed on the thermosetting resin. Thus, an epoxy resin, a polyamide resin, or a phenolic resin can be used. Examples of fiber substrates include glass clothes, nonwoven glass fabrics, synthetic fiber clothes, paper and the like. The preferred are glass clothes, nonwoven glass fabrics, or synthetic fiber clothes that are easy to impregnate with the filler. In accordance with the present invention, it is especially preferred that a combination of an epoxy resin and a glass cloth be used.

[0008] When a fibrous filler is used, the preferred length is 20-200  $\mu\text{m}$  and the preferred diameter is 6-10  $\mu\text{m}$ . In case of a powdered filler, the preferred diameter is 1-30  $\mu\text{m}$ . When those dimensions are exceeded, the substrate surface smoothness is insufficient. When the dimensions are below the aforesaid ranges, the surface smoothness is not increased, the viscosity becomes too high, and mixing tends to be difficult.

[0009] In accordance with the present invention, it is preferred that a glass cloth be used. No specific restriction is placed on the type of glass cloth. However, it is preferred that a glass cloth which is lighter than the usual glass cloth, or the glass cloth which is made thinner and uniform by loosening be used.

[0010] The amount of the filler adhered to the fibrous substrate depends on the substrate thickness, but the preferred amount is about 20 to 40 g/ $\text{m}^2$ . It is preferred that the content of resin in the final prepreg be 40-42 wt.%, as in usual prepgs.

[0011] The fibrous substrate is impregnated with the filler-containing varnish by coating or applying the filler with a coater, usually followed by drying to remove the solvent. In such a manner, a large amount of the filler is introduced into the gaps in the fibrous substrate and into the regions close to the surface. A prepreg is then obtained by impregnating with a varnish containing no filler. As a result, a prepreg can be obtained which contains a resin uniformly distributed in a fibrous substrate.

[0012]

A glass cloth ( $195 \text{ g/m}^2$ ) was impregnated with a filler-containing varnish used in Embodiment 1, followed by drying. The amount of the adhered filler was  $80 \text{ g/m}^2$ . A prepreg ( $435 \text{ g/m}^2$ ) with a resin content ratio of 37 wt.% was obtained.

[0019] Eight prepgs obtained in the above-described examples were laminated with copper foils (thickness  $35 \mu\text{m}$ ), and a laminate clad on both sides with copper was obtained by hot-press molding conducted by a usual method. Surface roughness and peeling strength of the copper foils were measured for all the laminates. The following results were obtained.

[0020]

[Table 1]

	Surface roughness ( $\mu\text{m}$ )	Peeling strength (kg/cm)
Embodiment 1	3.5	2.0
Embodiment 2	3	2.1
Embodiment 3	3	2.1
Comparative Example 1	4	1.9
Comparative Example 2	4.5	2.0
Comparative Example 3	4	1.8

[0021]

[Effect of the Invention] The above-described embodiments clearly demonstrate that the printed circuit substrate obtained by the method in accordance with the present invention has a small surface roughness and excellent smoothness. Moreover, the peeling strength of copper foils is high. Therefore, it is perfectly suitable as a printed circuit substrate for high-density patterning.

*Translator's Note: on September 4, 1991, the Applicant corrected the content of paragraphs [0009] and [0019]. The corrections are incorporated in the translation.*